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RESPONSE OF BROWN-HEADED NUTHATCHES TO THINNING OF PINE PLANTATIONS

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ABSTRACT.—Brown-headed Nuthatches (*Sitta pusilla*) reached their highest abundance within loblolly pine (*Pinus taeda*) plantations in the first year after thinning and declined in subsequent years. Commercial thinning of plantations resulted in a reduction of canopy cover, hardwood basal area, and understory density. Overall, the detection rates of nuthatches were low (19% of points surveyed) and no nuthatches were detected in stands before thinning. Nuthatches were more than three times as likely to be detected within survey points containing snags compared to those that did not. However, snag density did not vary significantly between stand ages. These patterns suggest that nuthatch distribution within stands may be influenced by snag distribution but that distribution among stands may be determined by the density and height of understory vegetation. *Received 13 March 1998, accepted 15 Sept. 1998.*

Prior to European settlement of North America, the Southeastern Coastal Plain was characterized by old-growth pine forests that covered more than 24 million ha (Croker 1979). This ecosystem was maintained by low-intensity ground fires caused by lightning strikes (Komarek 1964, 1974) and indigenous people (Bartram 1791, Ware et al. 1993). Fires occurred over vast areas at approximately 3–5 year intervals (Chapman 1932, Krusac et al. 1995) and maintained forests with an open midstory and dense ground cover of forbs and grasses (Platt et al. 1991).

Land clearing for agriculture, harvesting of longleaf pine (*Pinus palustris*) for the naval stores industry, and the suppression of wildfires severly reduced the extent of the southeastern pine ecosystem by the early 1800s (Ashe 1894, 1915; Pinchot and Ashe 1897). Currently, natural stands of longleaf pine are restricted to only about 1% of their former range (Ware et al. 1993).

Brown-headed Nuthatches (*Sitta pusilla*) are among a small group of species including the Red-cockaded Woodpecker (*Picoides borealis*) and the Bachman's Sparrow (*Aimophila aestivalis*) that are endemic to the southeastern pine ecosystem (Jackson 1988). The Red-cockaded Woodpecker and the Bachman's Sparrow have experienced significant population declines within the southeast region (Lennartz and Henry 1985, Dunning 1993); however, both have benefited from management practices that produce a habitat structure similar to the historic southeastern pine ecosystem (Gobris 1992, Plentovich et al. 1998).

The Brown-headed Nuthatch has also experienced a contraction of its former range (Jackson 1988), and according to data from the U.S. Fish and Wildlife Service's Breeding Bird Survey has been declining at a rate of more than 1.5% per year throughout much of the Southeast (Sauer et al. 1997). Very little is known about the ecology and habitat requirements of the Brown-headed Nuthatch and even less is known about how current forest management practices may affect its distribution. The purpose of this paper is to present some information on the use of pine plantations by Brown-headed Nuthatches relative to stand age and commercial thinning.

METHODS

This study was conducted in managed loblolly pine (*Pinus taeda*) plantations in eastern North Carolina (approximately 35° 50′ N, 77° 00′ W). These plantations are managed for pulpwood and sawtimber production on a 30–35 year rotation. After canopy closure, the plantations are thinned twice before final harvest. Thinnings reduce the number of trees, open the forest canopy, and allow for growth of understory vegetation.

We selected stands that represented seven different ages and relation to thinning: (1) 9–11 year old stands with closed canopies, (2) 13–16 year old stands within one year after the first commercial thinning, (3) 16–18 year old stands that were three years after first thinning, (4) 19–21 year old stands that were 5 years after first thinning, (5) 22–26 year old stands that were within 1 year after second thinning, (6) 28–29 year old stands that were 3 years after second thinning, and (7) 30–35 year old stands that were 5 years after second

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thinning. Six replicate stands (each > 24 ha) were selected for each stand type. Within each stand age, stands were chosen to minimize variation in planted stocking level and basal area of pine. Stands within each type were separated by at least 500 m.

Seven minute, fixed-radius (50 m) point counts were used to measure the density and frequency of occurrence of Brown-headed Nuthatches within study plantations. Four point counts were established within each stand and distributed evenly between edge and interior locations. Edge points were positioned 50 m from the stand edge such that the plot perimeter was tangential to the stand edge. For all stands, edge points were positioned on stand edges that were adjacent to logging roads. Interior points were positioned 150 m from the stand edge. Stands were surveyed three times between 1 June and 4 July 1997. Surveys were initiated 0.5 hr after sunrise and concluded within four hours.

The vegetation was sampled within all point count plots to determine (1) vegetation changes across the growing period, (2) vegetation responses to thinning, and (3) relationships between nuthatch distribution and vegetation. Linear transects were used for vegetation sampling parallel to the long, regularly distributed canopy openings created by row thinning. The length of vegetation transects was standardized to 25 m and the width varied between 4 and 7 m to accommodate variation in thinned and non-thinned longitudinal rows within stands. Four vegetation transects were established within each point count and equally distributed between thinned and non-thinned rows.

Habitat data were collected at two levels within transects. Counts of all large woody plants (> 8 cm dbh) and dead standing stems (snags) by type (hardwood vs pine) and stem diameter class (8–23, 24–38, > 38 cm dbh) were made over the entire 25 m transect. Pine and hardwood basal areas were estimated using the midpoint dbh for the two smaller diameter classes and 38 cm for the larger class (few trees were larger than 38 cm dbh). Additional information was collected within 2 × 2 m quadrats established at opposite ends of each transect. Information collected included canopy cover (measured in four cardinal directions of a compass by convex densiometer) and canopy height (measured using a clinometer), groundcover height and counts of all stems, shrubs, and saplings (> 0.5 m in height and < 8 cm dbh). Counts were summed to represent total groundcover density (stems/m^2).

A Kruskal-Wallis test was used to test for the influence of stand age on all habitat variables except for counts of snags. Because of the many zero values for counts of both Brown-headed Nuthatches and snags (i.e., data were distributed as a negative binomial), frequency of occurrence values were used to assess patterns among stand types. The relationship between nuthatches and habitat variables was assessed at the level of the point count using Kendall's rank correlation. Nuthatches were not detected in 9–10 year old stands, so this stand age was eliminated from all analyses and used only for descriptive purposes.

RESULTS

Stand age had a significant influence (Kruskal-Wallis test: df = 5, $P \leq 0.01$) on all habitat variables measured except the density of snags (Table 1). Canopy height and ground cover height were positively related to stand age whereas pine density was negatively related to stand age. All other significant variables increased with stand age but were also influenced by commercial thinning.

Detection rates for Brown-headed Nuthatches within pine plantations were relatively low. Nuthatches were detected in 15 of 42 (35.7%) pine stands included in the study and 32 of 168 (19%) individual point counts surveyed. Stand age had a significant influence on the detection of Brown-headed Nuthatches ($\chi^2_{\text{Yates Correction}} = 12.3$, df = 5, $P < 0.05$; Fig. 1). No nuthatches were detected in forest patches prior to first thinning. The number of points where nuthatches were detected was greatest in the year immediately following thinning and declined with time after thinning. Using survey points as statistical units, nuthatches were significantly associated with habitat variables that were directly influenced by thinning events. For example, nuthatch abundance was negatively correlated with canopy cover (Kendall $\tau = -0.12$, $n = 144$, $P < 0.03$), hardwood density ($\tau = -0.14$, $n = 144$, $P < 0.02$), and basal area of hardwoods ($\tau = -0.13$, $n = 144$, $P < 0.02$). In addition, nuthatch abundance was positively correlated with groundcover density ($\tau = 0.19$, $n = 144$, $P < 0.001$). Nuthatch density was not significantly correlated with canopy height ($\tau = -0.04$, $n = 144$, $P > 0.05$), pine density ($\tau = 0.04$, $n = 144$, $P > 0.05$) or pine basal area ($\tau = -0.02$, $n = 144$, $P > 0.05$).

Although stand type did not have a significant influence on the number of survey plots containing standing snags, and snags did not appear to result from thinning, nuthatches were positively correlated with standing snags ($\tau = 0.15$, $n = 144$, $P < 0.009$). In fact, nuthatches were over three times more likely to be detected within survey plots containing standing snags (12 of 32 plots, 37.5%) compared to plots that did not (13 of 122 plots, 11.6%; $\chi^2 = 7.35$, df = 1, $P < 0.007$).

DISCUSSION

It is generally thought that partially rotted wood is a prerequisite for cavity excavation

TABLE 1. Habitat characteristics of 7 stand types selected for study (n = 6 each). Median values are presented for all habitat variables except for snags where frequency of occurrence is presented.

Habitat variable	Stand age							Test statistic[a]	P
	9–10 years	1 year after first thin	3 years after first thin	5 years after first thin	1 year after second thin	3 years after second thin	5 years after second thin		
Canopy height (m)	17.5	18.1	19.4	21.9	23.2	25.3	26.3	113.4	< 0.01
Canopy cover (%)	96.6	77.1	84.9	86.4	82.7	94.9	95.2	78.1	< 0.01
Pine density (stems/ha)	1070.0	287.1	330.0	210.0	160.0	190.0	170.0	65.4	< 0.01
Pine basal area (m^2/ha)	35.3	8.0	11.0	11.8	12.2	20.9	20.4	78.9	< 0.001
Hardwood density (stems/ha)	0.0	17.4	100.0	90.0	70.0	120.0	150.0	20.7	< 0.001
Hardwood basal area (m^2/ha)	0.0	0.0	7.0	6.3	4.6	7.9	10.5	22.9	< 0.01
Snag frequency (# of points detected)	5	7	6	3	8	5	3	3.35	> 0.05
Groundcover density (stems/m^2)	4.8	8.4	7.1	7.5	10.1	6.9	9.5	15.3	< 0.01
Groundcover height (m)	1.0	1.5	1.5	2.0	2.0	2.3	2.5	112.1	< 0.01

[a] Test statistic and associated P values are based on Kruskal-Wallis ANOVA (H, df = 5) results except for snag frequency which is based on results from a χ^2 test (df = 5) with Yates correction factor.

by Brown-headed Nuthatches, and the majority of cavities reported have been located in snags (McNair 1984). In general the population density of cavity-nesting birds is positively related to snag density (Cunningham et al. 1980, O'Meara 1984, Raphael and White 1984). In Florida, a large percentage of the variation in the density of cavity-nesting birds (including Brown-headed Nuthatches) was explained by snag density and dispersion (Land et al. 1989). Snag density has been shown to be lower in pine plantations than in natural stands (McComb et al. 1986), and was low in the plantations we surveyed. Brown-headed Nuthatches were significantly more likely to be detected within survey points that contained snags. The possibility that snag density may serve to limit overall nuthatch density within loblolly pine plantations requires further investigation. Because nuthatch density was influenced by thinning and snag density, snag density alone does not explain nuthatch distribution among pine stands.

Brown-headed Nuthatches exhibited a rapid response to thinning. Nuthatches were not detected within pine plantations prior to the first thinning but reached their highest densities within the first year after thinning. This response suggests that thinning activities may, in some way, enhance habitat structure for nuthatches. Thinning activities were shown to reduce canopy cover, reduce the density and basal area of hardwoods, and increase groundcover density.

Although the importance of canopy cover to the use of pinelands by Brown-headed Nuthatches has not been explored, Engstrom and coworkers (1984) reported that nuthatch abundance declined as the density of midstory hardwoods increased. This result is consistent with our observations that nuthatches were less common in years after thinning, as the density and basal area of hardwoods increased.

The effects of burning hardwoods on stand use by Brown-headed Nuthatches is similar to that of thinning. Nuthatches used (45 nuthatches/km^2) mature longleaf pine stands that were regularly burned in Florida (Repenning and Labisky 1985), but not stands with well developed understories (Hirth et al. 1991). Nuthatch density decreased with time following burning (Engstrom et al. 1984, Wilson et

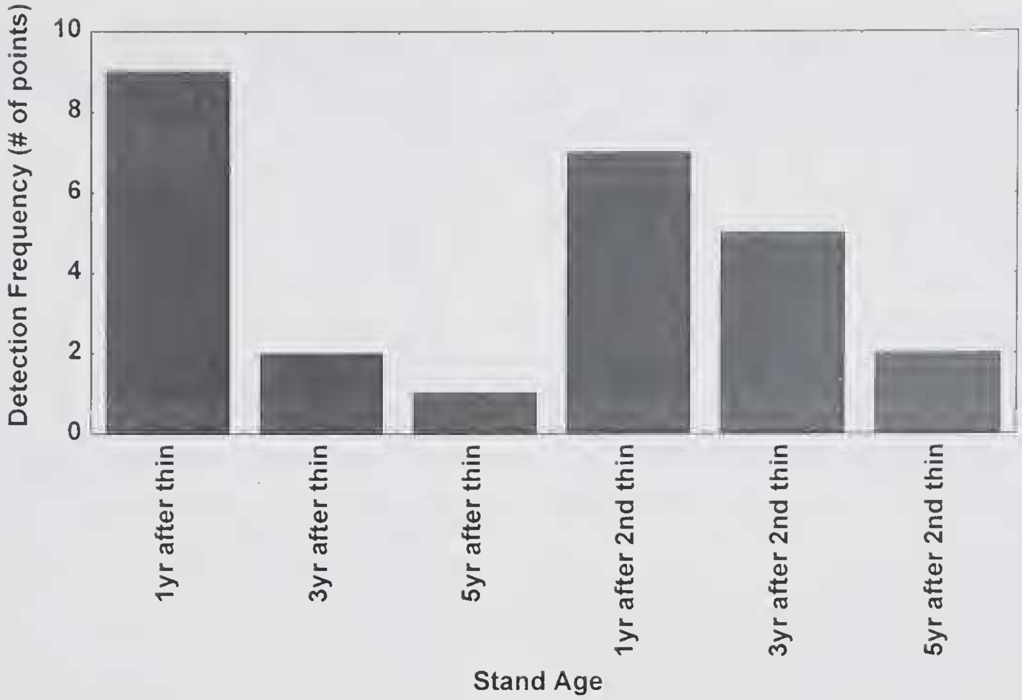

FIG. 1. Detection frequency (# of point counts) of Brown-headed Nuthatches in commercially thinned pine plantations in eastern North Carolina (n = 24 point counts for each stand type). Frequency distribution between stand ages was significantly different from an even distribution ($\chi^2_{\text{Yates correction}} = 12.3$, df = 5, $P < 0.05$).

al. 1995), similar to the decline in nuthatches we observed following thinning.

One possible explanation for the inverse relationship between the density of understory vegetation and numbers of Brown-headed Nuthatches is that vegetation may obscure potential cavity locations. Brown-headed Nuthatch cavities are frequently excavated in relatively low positions; usually below 3.66 m (n = 309; McNair 1984). Most (68%) cavities were located in tree stumps (McNair 1984) suggesting that the potential for increasing cavity height may be limited. Regeneration of understory and groundcover vegetation was rapid in the current study such that low cavity positions could be obscured quickly, but the impact on patch use by Brown-headed Nuthatches is unknown.

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LITERATURE CITED

Ashe, W. W. 1894. The forests, forest lands, and forest products of eastern North Carolina. N.C. Geol. Surv. 5:1–128.

Ashe, W. W. 1915. Loblolly or North Carolina pine. N.C. Geol. Surv. and Econ. Surv. 24:1–176.

Bartram, W. 1791. Travels through North and South Carolina, Georgia, east and west Florida. Dover Publications, New York.

Chapman, H. H. 1932. Is the longleaf type a climax? Ecology 13:328–334.

Conner, R. N. and D. C. Rudolph. 1991. Effects of midstory reduction and thinning in Red-cockaded Woodpecker cavity clusters. Wildl. Soc. Bull. 19: 63–66.

Croker, T. C., Jr. 1979. Longleaf pine. J. For. Hist. 23:32–43.

Cunningham, J. B., R. P. Balda, and W. S. Gaud. 1980. Selection and use of snags by secondary cavity-nesting birds of the ponderosa pine forest. U.S. For. Serv. Res. Pap. RM-222:1–15.

Dunning, J. G. Jr. 1993. Bachman's Sparrow *in* The birds of North America, no. 38 (A. Poole, P. Settenheim, and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C.

Engstrom, R. T., R. L. Crawford, and W. W. Baker. 1984. Breeding bird populations in relation to changing forest structure following fire exclusion: a 15-year study. Wilson Bull. 96:437–450.

Gobris, N. M. 1992. Habitat occupancy during the breeding season by Bachman's Sparrow at Piedmont National Wildlife Refuge in central Georgia. M.Sc. Thesis, Univ. of Georgia, Athens.

Hirth, D. H., L. D. Harris, and R. F. Noss. 1991. Avian community dynamics in a peninsular Florida longleaf pine forest. Fla. Field. Nat. 19:33–48.

Jackson, J. A. 1988. The southeastern pine forest ecosystem and its birds: past, present, and future. Pp. 119–159 *in* Bird conservation 3 (J. A. Jackson, Ed.). Univ. of Wisconsin Press, Madison.

Komarek, E. V., Sr. 1964. The natural history of lightning. Proc. Tall Timbers Fire Ecol. Conf. 3:139–183.

Komarek, E. V., Sr. 1974. Effects of fire on temperate forests and related ecosystems: southeastern United States. Pp. 251–278 *in* Fire and ecosystems (T. T. Kowalski and C. E. Ahlgren, Eds.). Academic Press, New York.

Krusac, D. L., J. M. Dabney, and J. J. Petrick. 1995. An ecological approach to recovering the Red-cockaded Woodpecker on southern National Forests. Pp. 61–66 *in* Red-cockaded Woodpecker: recover, ecology and management (D. L. Kulhavy, R. G. Hooper, and R. Costa, Eds). Center for Applied Studies in Forestry, College of Forestry, Stephen F. Austin State Univ., Nacogdoches, Texas.

Land, D., W. R. Marion, and T. E. O'Meara. 1989. Snag availability and cavity nesting birds in slash pine plantations. J. Wildl. Manage. 53:1165–1171.

Lennartz, M. R. and V. G. Henry. 1985. Recovery plan for the Red-cockaded Woodpecker. U.S. Fish and Wildlife Service, Atlanta, Georgia.

McComb, W. C., S. A. Bonney, R. M. Sheffield, and N. D. Cost. 1986. Snag resources in Florida—are they sufficient for average populations of primary cavity nesters? Wildl. Soc. Bull. 14:40–48.

McNair, D. B. 1984. Clutch-size and nest placement in the Brown-headed Nuthatch. Wilson Bull. 96: 296–301.

O'Meara, T. E. 1984. Habitat-island effects on the avian community in cypress ponds. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 38: 97–110.

Platt, W. J., J. S. Glitzenstein, and D. R. Streng. 1991. Evaluating pyrogenicity and its effects on vegetation in longleaf pine savannahs. Proc. Tall Timbers Fire Ecol. Conf. 17:143–161.

Pinchot, G. and W. W. Ashe. 1897. Timber trees and forests of North Carolina. N.C. Geol. Surv. 6:1–227.

Plentovich, S., J. W. Tucker, Jr., N. R. Holler, and G. E. Hill. 1998. Enhancing Bachman's Sparrow habitat via management of Red-cockaded Woodpeckers. J. Wild. Manage. 62:347–354.

Raphael, M. G. and M. White. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wildl. Monogr. 86:1–66.

Repenning, R. W. and R. F. Labisky. 1985. Effects of even-age timber management on bird communities of the longleaf pine forest in northern Florida. J. Wildl. Manage. 49:1088–1098.

Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American breeding bird survey results and analysis, version 96.4. Patuxent Wildlife Research Center, Laurel, Maryland. URL = http://www.mbr.nbs.gov/bbs/bbs.html

Ware, S., C. Frost, and P. D. Doerr. 1993. Southern mixed hardwood forest: the former longleaf pine forest. Pp. 447–494 *in* Biodiversity of the southeastern United States (W. H. Martin, S. G. Boyce, and A. C. Echternacht, Eds.). John Wiley and Sons, Inc., New York.

Wilson, C. W., R. E. Masters, and G. A. Bukenhofer. 1995. Breeding bird response to pine-grassland community restoration for Red-cockaded Woodpeckers. J. Wildl. Manage. 59:56–67.